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ABSTRACT

This biogeography module is designed for students wishing to study evolutionary interrelationships with the physical environment. Topics studied include various aspects of historical biogeography and evolution. Categories included are: (1) barriers to the dispersal or organisms, (2) the zoogeographic regions, (3) genetic change, (4) selection, and (5) the history of life. This course is suggested for students planning to major in biology or become professional biologists. The performance objectives are listed, the course outline presented and the entire curriculum presented. At the conclusion of the module it is hoped that the student will be able to discuss critically the future of man as a highly evolved species. (EB)

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AUTHORIZED COURSE OF INSTRUCTION FOR THE QUINMESTER PROGRAM

LIFE IN THE PAST - BIOGEOGRAPHY

5314.16

SCIENCE

(Experimental)

DADE COUNTY PUBLIC SCHOOLS

DIVISION OF INSTRUCTION•1971

SE 016 516

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SCIENCE

(Experimental)

Written by Joseph P. Adams
for the
DIVISION OF INSTRUCTION
Dade County Public Schools
Miami, Florida
1972

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LIFE IN THE PAST - BIOGEOGRAPHY

COURSE DESCRIPTION

This course is designed for the student who wishes to study evolutionary interrelationships with the physical environment.

Topics to be studied include various aspects of historical biogeography and evolution. Some of the more important categories are: barriers to the dispersal of organisms, the zoogeographic regions, genetic change, selection, speciation and the history of life.

ENROLLMENT GUIDELINES

The course is elective and is suggested for students who may plan to major in biology in college or to be professional biologists.

STATE ADOPTED TEXTBOOKS *

1. Biological Science Curriculum Study. Biological Science: Molecules to Man. 2nd ed. Boston: Houghton Mifflin, 1968.

2. Biological Sciences Curriculum Study. High School Biology. 2nd ed. Chicago: Rand McNally, 1968.

* Since the state adopted textbooks only contained a somewhat limited amount of information in this area, the majority of the information will be obtained from three other texts:

1. McAlester, A. Lee. The History of Life. Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1968.

2. Dobzhansky, Theodosius. Evolution, Genes and Man. New York: Wiley and Sons, 1955.

3. Weisz, Paul H. The Science of Biology. 3rd ed. New York: McGraw-Hill, 1967.

PERFORMANCE OBJECTIVES

1. Given plant and animals fossils, the student will identify the geological periods in which they existed.

2. The student will explain why pre-Cambrian rocks usually are devoid of fossils.

3. The student will distinguish between examples of adaptive radiation and of replacement.

4. Given various examples of flora and fauna, the student will discuss critically, hypotheses of convergence and divergence.

5. The student will cite evidence for the continental drift hypothesis.

6. The student will relate the Grand Canyon formation to speciation.

7. The student will identify ecological and behavioral barriers to the dispersal of organisms.

8. The student will classify various organisms according to their zoogeographic regions.

9. Given 3 possible routes of dispersal, the student will differentiate sweepstake bridges, filter bridges and corridor bridges.

10. The student will specify the assumptions and limitations of the various mechanisms of evolution.

11. The student will identify artificial and natural agents of selection.

12. The student will discuss critically the concept of "survival of the fittest."

13. Given various examples, the student will generalize from data the mechanisms of speciation.

14. Given samples of various rocks, the student will identify fossils by their:

    a. Structure
    b. Time of deposition

15. The student will contrast the fossils of pre-historic organisms with their modern counterparts or analogs.

PERFORMANCE OBJECTIVES (Continued)

16. The student will differentiate between monera and protista; between fungi and algae.

17. The student will predict the advantages and disadvantages of the transition to a terrestrial environment.

18. Given various organisms, the student will classify their origin in terms of the carboniferous period, the age of reptiles or the age of mammals.

19. Given exemplary behavior patterns, the student will discern how selection favored the ground dwelling primates.

20. The student will discuss critically the future of man as a highly evolved species.

COURSE OUTLINE

I. Historical Biogeography

A. The geological periods and epochs

B. Evidence of organismic change

1. From Cambrian rocks

2. Absence of fossils in pre-Cambrian rocks

C. Extinction and replacement

D. Adaptive radiation

1. Cotylosaurs

2. Dinosaurs

E. Convergence and divergence

F. Changes in the distribution of land and water

1. The continental drift hypothesis

a. Pangea
b. Holarctica and Gondwana
c. Present distribution of continents

2. The six biogeographic regions

COURSE OUTLINE (Continued)

G. Barriers to the dispersal of organisms -- physical

1. Effects of diastrophism and the erosive action of water -- Grand Canyon formation

2. Water formation

a. Continental
b. Volcanic

H. Barriers to the dispersal of organisms -- ecological

1. Climatic

2. Altitude effect

I. Barriers to the dispersal of organisms -- time and rate of reproduction

1. Circadial rhythms

2. Reproductive isolation

a. Controlled breeding
b. Allopatric populations

J. Barriers to the dispersal of organisms -- specific behavioral patterns

1. Introspecific infertility

2. Sympatric species

K. Zoogeographic or faunal regions

1. Nearctic fauna -- U. S., Canada and highlands of Mexico

2. Palearctic fauna -- Europe, Asia, southern slope of the Himalayas, Africa, north of the Sahara desert

3. The Australian faunal region

a. Adaptive radiation of the marsupial mammals
b. Effect of rabbit introduction into Australia

COURSE OUTLINE (Continued)

4. Other faunal regions

a. Neotropical -- South America, Central America and Mexican lowland
b. Ethiopian -- Africa, south of the Sahara
c. Oriental or Indo-Malayan -- southern Asia and Indonesia

L. Means and routes of dispersal

1. Sweepstakes bridges

2. Filter bridges

3. Corridor bridges

II. Evolution -- Genetic Change

A. Of bacteria

1. Transformation

2. Transduction

3. Mutation

a. "Spontaneous"
b. Via mutagenic agents

(1) Photoreactivation and X-rays
(2) Various chemicals
(3) High temperature

B. Of fruitflies

C. Long range effects of mutations

III. Evolution -- Selection

A. Physiological differences

1. Utilization of creatine and arginine phosphates

a. Invertebrates -- chiefly arginine
b. Vertebrates -- chiefly creatine

COURSE OUTLINE (Continued)

2. Serological reactions

a. Ability to produce antibodies
b. Immune reaction -- of rabbits to human serum

B. External and internal anatomical characteristics

1. The giraffe neck

2. The appendix and caecum

C. Environmental effects -- Johannsen's experiments

1. Ineffectiveness of selection in pure lines

2. Substantiation of Johannsen's work using clones

C. Agents of selection

1. Climate

2. Location of food supply -- giraffe

3. Artificially induced environmental changes -- moths

E. Artificial selection

1. Pedigree breeding

2. Hybridization

3. Grafting

F. Natural selection

1. Interpretation of "survival of the fittest"

2. Adaptability and adaptive plasticity of the phenotype

IV. Evolution -- Speciation

A. Geographic isolation and variation

1. The Kaibab and Abert squirrels

2. North American frogs

COURSE OUTLINE (Continued)

B. Reversal of reproductive isolation

1. By domestication -- zebroids, mules, etc.

2. The sterility of hybrids

C. Monophyletism vs. polyphyletism

V. Evolution -- History of Life

A. The fossil record

1. Pre-Cambrian

a. At about 3.1 billion years -- microstructures in chert of Onverwacht, South Africa
b. The cryptozoic period, or period of hidden life
c. The Cambrian and post-Cambrian periods

2. Cambrian

a. Since 600,000,000 to 5,000,000,000 years ago
b. Also known as the Phanerozoic or "known life" period
c. The most ancient undisputable fossil remains estimated to be about 500,000,000 years old

B. Record of extinct species

1. Trilobites

2. Dinosaurs

3. Giant ferns

C. Evolution of present day organisms

1. Hyracotherium or Eohippus to modern horse

2. "Living fossils"

a. Coelacath fish
b. Horseshoe crab
c. Tuatara (Sphenodon)

COURSE OUTLINE (Continued)

D. History of life

1. The most ancient remains probably lost

   a. Metamorphosis of rocks
   b. Devoured by primitive heterotrophs

2. The heterotroph hypothesis

3. Monera and protista -- from primordial cells

4. Blue-green algae -- the most primitive photosynthesizers

5. Fungi -- probably derivation from flagellate ancestry

6. The slime mold -- unicellular or multicellular

7. Diversity of early aquatic organisms

8. The appearance of chordates

   a. Urochordates
   b. Cephalochordates
   c. Vertebrates

9. Transition to the terrestrial environment

   a. Early amphibious types (Labyrinthodonts)
   b. The lobe-finned fish (Crossopterygians)
   c. The "walking catfish" -- a modern phenomenon

10. Advantages and disadvantages of terrestrial life

   a. Advantages

      (1) Refuge from predators
      (2) Oxygen content of the atmosphere
      (3) Removal of wastes from the immediate environment of the organisms

   b. Disadvantages

      (1) The need for a constant water supply
      (2) Greater exposure to possibly damaging electromagnetic radiations

COURSE OUTLINE (Continued)

11. The Carboniferous period

    a. Evolution of insects

        (1) Rarity of fossilization
        (2) Means of fossilization

            (a) Delicate impressions of wings in fine mud
            (b) Preservation in amber

        (3) Oldest known species resembling modern dragonfly but with wingspread up to 3 feet

    b. Flora of the carboniferous period

12. The Age of Reptiles

    a. Stem reptiles -- the cotylosaurs
    b. Mammal-like reptiles
    c. Marine reptiles -- the return to the sea
    d. Thecodonts

        (1) Pterosaurs -- flying reptiles
        (2) Dinosaurs
        (3) Surviving members -- the crocodiles

13. The Age of Mammals, except man

    a. Diversity of mammals

        (1) Aquatic -- Cetacea (whales)
        (2) Terrestrial -- Monotremes, Marsupials, Rodents, Insectivores, Carnivores, Primates, etc.
        (3) Aerial -- Chiroptera (bats)

    b. Fossilized and extinct species

        (1) Mammal-like reptiles of the Triassic period
        (2) Prosimians -- the pre-monkeys, including lemur survivors
        (3) Fossil record of the horse

14. The Age of Man

    a. Paleocene and Eocene epochs -- only fossil primates are prosimians

COURSE OUTLINE (Continued)

b. Oligocene epoch -- anthropoid superfamilies

(1) Ceboidea -- New World monkeys
(2) Cercopithecoidea -- Old World monkeys
(3) Hominoidea -- apes and man

c. Ground dwelling primates

(1) Upright stance freed hands from use in locomotion
(2) Hands became used exclusively for tool making and weapon throwing
(3) More precise vision

d. Australopithecus ($>$ 500,000 years old)

(1) Limb structure identical to that of modern man
(2) Brain volume about $\frac{1}{2}$ that of modern man

e. Homo erectus

(1) Brain volume increased
(2) 900-1100 cm^3 compared to 1400-1600 cm^3 in modern man

f. Homo sapiens

(1) Modern man
(2) Present evidence indicates Neanderthal man is of the same species

g. Differentiating characteristics of modern man

(1) True speech
(2) Culture
(3) Complex reasoning capacity

h. Diversity of human cultures

15. The future of man as a highly evolved species

a. His influence on his environment

(1) Beneficial

(a) Short term
(b) Long term

COURSE OUTLINE (Continued)

(2) Harmful

(a) Short term
(b) Long term

b. Influence on and control of other organisms

(1) Artificial selection and breeding
(2) Hybridization
(3) Pesticides
(4) Mutagenic agents

c. Influence on his own evolution

(1) Accidentally induced mutations
(2) Ectogenesis -- test tube pregnancy
(3) Human "engineering" -- "super-humanization"

d. Human population and growth

(1) Malthus' theory
(2) Means of population control

e. Geographic variation in human populations

(1) Climatic factors
(2) Terrestrial factors

EXPERIMENTS

Geology and Earth Sciences Sourcebook, American Geological Institute. New York: Holt, Rinehart and Winston, 1962.

1. Metamorphic rocks (pp. 50-51)
2. Demonstration of isostasy (pp. 122-123)
3. Ripple tank demonstration (p. 109)
4. Permineralization, replacement and petrification (p. 275)

Space Resources for Teachers: Biology. Washington, D.C.: NASA, 1969.

5. The Effect of Ultraviolet Radiation on Nutrient Synthesis (p. 168)

EXPERIMENTS (Continued)

Dade County Curriculum Bulletin. Advanced Biology Course of Study and Laboratory Guide. Miami, Florida: Dade County Public Schools, 1966.

6. Drosophila genetics (pp. 122-126)
7. Induction of polyploidy by the use of Colchicine (pp. 127-129)

Weisz, Paul H. The Science of Biology Laboratory Manual. 3rd ed. New York: McGraw-Hill, 1967.

8. Identification of Monera and Protista (p. 43)

DEMONSTRATIONS

Geology and Earth Sciences Sourcebook, American Geological Institute. New York: Holt, Rinehart and Winston, 1962.

1. Crystal Growing (p. 23)
2. Classification of Rocks (pp. 54-57, 91-92)
3. Carbon Imprints of Leaves (pp. 275-276)
4. Interpretation of Animals from their Hard Parts (p. 277)

RELATED PROBLEMS

1. About how old is ichthyosaurus?
2. What are some methods of determing geologic time?
3. How do geologist and paleontologists know the stratigraphic range of index fossils?
4. What is the origin of cherty iron formations of the pre-Cambrian age?
5. How does one construct a topographic profile?

SPECIAL EQUIPMENT

1. Geiger counter, preferably with scaler detector
2. Igneous, metamorphic and sedimentary rocks - representative samples
3. Fossilized rocks
4. Ultraviolet light source

TEXTS

1. Biological Sciences Curriculum Study. Biological Science: Molecules to Man. Rev. Ed. Boston: Houghton Mifflin Company, 1968.
2. Biological Sciences Curriculum Study. High School Biology. 2nd ed. Chicago: Rand McNally, 1968.
3. Dobzhansky, Theodosius. Evolution, Genes and Man. New York: Wiley and Sons, 1955.
4. McAlester, A. Lee. The History of Life. Englewood Cliffs, New Jersey. Prentice-Hall Inc., 1968.
5. Weisz, Paul H. The Science of Biology. New York: McGraw-Hill, 1967.

(See also laboratory manuals under "Experiments")

PLACES TO VISIT

1. Museum of Science
2. University of Miami
   Geology Department

READING LISTS

1. Abelson, P. H. "Effects of Ultraviolet Light on the Primitive Environment", Carnegie Institution of Washington Yearbook. Washington, D. C.: Carnegie Institute, #53, 1956-57 pp. 179-185.

2. Abelson, P. H. "Some Aspects of Paleobiochemistry", Annuals of N.Y. Academy of Science. 69: 276-285. 1957.

3. Alexander, J. Life, Its Nature and Origin. New York: Reinhold, 1948.

4. Arnold, C. A. "Current Trends in Paleobotany", Earth Science Review. Amsterdam, Netherlands: 4: 283-309, 1968.

5. Barghoorn, E. S. and Schoof, J. W. "Microorganisms Three Billion Years Old From the Pre-Cambrian of South Africa", Science. Washington, D.C.: 152, 758-63, May 6, 1966.

6. Blum, H. F. "Dimensions and Probability of Life", Nature. London: 206 April 16, 1965. pp. 131-132.

7. Calvin, M. Chemical Evolution-Molecular Evolution Toward the Origin of Living Systems on the Earth and Elsewhere. New York: Oxford University Press, 1969.

8. Dole, M. "The Natural History of Oxygen", Journal General Physiology. New York: 49, Suppl. 5-27, September, 1965.

9. Echlin, P. "Origins of Photosynthesis", Science Journal. London: 2, 42-47, April, 1966.

10. Ehler, E. G. and Stiles, D. V. "Fossil Bacteria in Pyrite", Science. Washington: 148, 1719-21, June 25, 1965.

11. Ehrensvaerd, G. Life Origin and Development. Chicago: University Press, 1962.

DADE COUNTY FILMS

1. Nuclear Radiation: Detectors
   AV# 1-11459, 15', C

2. Rocks and the Record (AIBS, Pt. 10, No. 9)
   AV# 1-30349, 28', C

DADE COUNTY TRANSPARENCIES (AND UNITS)

1. Evolution of North America, The: Tertiary Period
   AV# 2-00312, C

2. Evolution of North America, The: Key to Rock Types
   AV# 2-00315, C

3. Evolution of North America, The: Geologic Time Scale
   AV# 2-00314, C

DADE COUNTY SLIDES

1. Fossil Invertebrates
   5-20127, C

2. Fossil Vertebrates
   5-20126, C

DADE COUNTY MODELS

1. Age of the Dinosaurs
   6-00051, C, 13 specimens

2. Sedimentary and Metamorphic Rocks
   6-00119, C, 12 items

3. Rocks and Minerals
   6-00116, C, 56 items

DADE COUNTY SINGLE CONCEPT FILMS

1. Nuclear Radiation Series
   7-30011, 20', C

MATCH SHEET--[illegible] OF [illegible]

Objectives	[illegible]	Student Texts	[illegible]	Films	Models	Games or Demos	Single Concept Films
1		H.O.L. pp. 54, 54,55	11	3,4	2	4	
2	1	H.O.L. pp. 12-15	2,?	2	3	2	
3		H.O.L. pp. 38, 62,59-61 E.G.M. pp. 291-196,307-326		3,4		3	
4		E.G.M. pp. 167, 237,247-291		5			
5	2	E.G.M. p. 317		7			
6	3	E.G.M [illegible]. 178		2			
7		E.G.M. [illegible]. 170, 187,188					
8		E.G.M. pp. 315-317					
9		E.G.M. pp. 313-317					
10	5,6	E.G.M. pp. 83-87, 92-100		5			1
11	7	E.G.M. pp. 83-89, 245-246		1			1
12		E.G.M. pp. 112-113 344-345	3				
13		E.G.M. pp. 168-184					
14		H.O.L. pp. 53-56			3,4	1,2	
15		H.O.L. p. 78 E.G.M. pp. 292-297,365-673			1,2		
16	8		Weiz, Science of Biology				
17	5	H.O.L. pp. 78-80		6			
18	4	H.O.L. pp. 68,89-97,103-107,115-127					
19		H.O.L. pp. 129-138 E.G.M. p. 470					
20				5,7			1

NOTE: H.O.L.--[illegible]
E.G.M.--[illegible]